SYLLABUS

Of a COURSE of

LECTURES

On the moſt Intereſting PARTS of

MECHANICS,
HYDROSTATICS,
HYDRAULICS,
PNEUMATICS,
ELECTRICITY, and
ASTRONOMY.

By JAMES FERGUSON, *F. R. S.*

Philoſophia Mater omnium bonarum Artium eſt.
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PREFACE.

TO ſhew how the natural Strength may be aſſiſted by Art, and how to conſtruct Machines of ſufficient Powers for that Purpoſe; — to compute the Power of any Machine or Engine already conſtructed, and point out its Perfections or Defects; — to explain the wonderful Properties of Water and Air, and prove them by the moſt plain and obvious Experiments; — to ſhew the Methods by which Water may be raiſed to any given Height, for Gentlemen's Seats, &c. and what Degree of Power is requiſite for that Purpoſe; — to inveſtigate the Laws by which the ALMIGHTY regulates and governs all the Celeſtial Motions around us, and to account for the general Appearances depending on theſe Laws and Motions; — to demonſtrate the Truth of a general Providence, and of ſome very remarkable Parts of Scripture; — and, in ſhort, to make Mankind ſo much the wiſer and better, as to promote both their temporal and eternal Happineſs, are Subjects of too intereſting a Nature to need any Recommendation.

For theſe Purpoſes the following Courſe is chiefly intended; which is a full Anſwer to a very common Queſtion, namely, What is the Uſe of Philoſophy?

SYLLABUS

Of a COURSE of

LECTURES.

LECTURE I.

On the Mechanical Powers.

A PLAIN and eaſy Method of computing the Power or Advantage gained by all Sorts of Machines and Engines, be they ever ſo ſimple or complex. — This Method applied,

1. To the Lever.
2. To the Wheel and Axle.
3. To the Pullies.
4. To the Inclined Plane.
5. To the Wedge.
6. To the Screw.
7. To a compound Engine, in which all theſe ſix ſimple Machines are included.
8. To a Model of the fine Crane at Briſtol.
9. To a new Crane with four different Powers for different Weights, invented by Mr. *Ferguſon.*

A new Pyrometer ſhewn and explained, that makes the Expanſion of Metals by Heat viſible to the ninety-thouſandth Part of an Inch.

LECTURE II.

On Mills, Wheel-Carriages, &c.

The Centre of Gravity, and Line of Direction, explained.

A double Cone ſhewn, that ſeems to aſcend whilſt it is actually deſcending.

A Machine for diminiſhing Friction, ſhewn.

The Utility of Broad-Wheels in Land-Carriages demonſtrated to exceed that of Narrow-Wheels.

The Abſurdity of the common Method of loading the Waggons, proved by Experiment; and a better Method pointed out.

That Carriages with large Wheels are more eaſily drawn than with ſmall Wheels, proved.

A Method of finding what degree of Power is requiſite for drawing a loaded Waggon or Cart up Hill, when the Slope of the Hill, and the Weight of the Carriage and Load, are known.

A curious Model of a Reading Deſk, ſhewn.

A moſt curious Silk Reel (invented by Mr. *Verrier* of *Somerſetſhire*), ſhewn.

The Structure of Water-Mills, Hand-Mills, and Sawing-Mills, explained by Means of Working Models.

A Method for conſtructing Water-Mills in the moſt perfect Manner, ſhewn.

The Method of driving the Piles at *Weſtminſter* Bridge explained by Means of a Working Model of the Engine uſed for that Purpoſe.

A Proof, that the Force of the Wind on Windmill Sails is as the Square of the Velocity of the Wind.

LECTURE III.

On Hydroſtatics.

That Fluids weigh as much in their own Elements as they do in Air, proved.

That the Preſſure of Fluids is in Proportion to their perpendicular Heights, without any Regard to their Quantities, proved.

That Fluids preſs equally in all Manner of Directions, proved,

That, from this Preſſure, ſolid Lead may be made to ſwim in Water, and light Wood to lie at the Bottom of a Veſſel filled with Water.

That an Ounce of Water in a Tube will raiſe and ſupport more than ſixteen Pound Weight of Lead.

The Hydroſtatical Paradox ſhewn and explained.

That the Quantity of Water diſplaced by a Ship is equal to the Weight of the Ship, and all that is in it, proved.

The Working of Syphons ſhewn and explained. And thence,

The *Tantalus*'s Cup. — The intermitting Fountain, ſhewing the Cauſe of the periodical Running and Stopping of ſome Springs, and of the ebbing and flowing of Wells.

Reciprocating Springs explained, and ſhewn by a Machine.

LECTURE IV.

...ities, and Hydraulic Engines.

...a Solid Body is immerſed and ſuſpended ...id, it looſes as much of its Weight as its ...k of the Fluid weighs; and that the Weight loſt by the Solid is imparted to the Fluid. — Hence,

The Method of finding the Specific Gravities of Bodies, or their comparative Weights, Bulk for Bulk; and thereby to diſcover whether any ſuſpected Piece of Gold, or other Metal, be genuine or counterfeit.

A working Model of ARCHIMEDES's ſpiral Pump ſhewn and explained.

The Operations of the common ſucking, forcing, and lifting Pumps, explained, and ſhewn by Glaſs Models.

A working Model of a Quadruple forcing Pump Mill, for raiſing Water to any given Height, ſhewn and explained.

A working Model of the *Perſian Wheel* ſhewn.

A working Model of the great Engine at *London* Bridge, and of the Engine that raiſes Water from the *Hungarian* Mines, ſhewn and explained.

A working Model of a new Fire-Engine, ſhewn and explained.

LECTURE V.

On the Air Pump. —The Weight of the Air.

The Nature and Properties of the Air deſcribed.

The Mechaniſm of the Air-Pump explained.

An Experiment, ſhewing, that no Air can paſs from the lateral into the longitudinal Pores of Wood.

That,

That, without Air, there could be no Sound, ſhewn by a Bell, that will not ring in a Glaſs out of which the Air is exhauſted.

That Air reſiſts the Motion of Bodies, is ſhewn,

By the unequal Velocities of a Guinea and the Down of a Feather falling in Air, and their falling equally quick in a Glaſs exhauſted of Air.

That the Air has Weight, is ſhewn,

1. By weighing a known quantity of it in Scales; and thereby to know the Weight of any other Quantity thereof.
2. By its preſſing down the Hand on an open Glaſs, when the Air is exhauſted out of the Glaſs.
3. By its breaking a Bladder on an exhauſted Glaſs.
4. By its forcing Quickſilver through the Pores of Wood.
5. By the *Toricellian* Experiment, ſhewing the Nature and Operations of the common Barometer.
6. By the Operation of the common Pump; in which it is proved, that the Pump raiſes Water by Means of the Preſſure of the Air, and not by Suction.
7. By its Effect on two Glaſſes; in which it is proved, to a Demonſtration, that the Glaſſes are held down on the Air-Pump by the Preſſure of the Air, and not by any ſuch Thing as Suction of the Pump.
8. By its forcing Water into a hollow Ball of Glaſs exhauſted of Air.
9. By an artificial Fountain—And,
10. By the great Force required to ſeparate two hollow Hemiſpheres of Braſs when the Air is exhauſted out of them.

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LECTURE VI.

On the Air-Pump.——The Spring of the Air.

An Experiment to prove that the Air preſſes upward. —— to prove that Bodies looſe part of their Weight in Air.

—— to prove that Flame and Smoke do not aſcend in Air on account of poſitive Levity, but becauſe they are lighter than Air.

—— to ſhew by what Means Fiſhes can raiſe themſelves to the Surface of the Water, or let themſelves down to the Bottom.

The Spring of the Air ſhewn,

1. By a Bladder that appears almoſt empty in common Air, but ſeems full blown in an exhauſted Glaſs.
2. By about ten Grains of Air, which expands ſo ſtrongly when the outward Preſſure is taken off, as to raiſe and ſupport 16 Pound Weight of Lead.
3. By forcing the Water out of a hollow Ball of Glaſs.
4. By three artificial Fountains.
5. By transferring Air out of one Veſſel into another.
6. By the Bubbles in warm Water or Beer, which makes Beer ſeem to boil when the Preſſure of the Air is removed. — Alſo by the amazing Quantity of Air in a ſmall Piece of Wood.
7. A Demonſtration, that the Spring of the Air is equal to the Preſſure thereof.
8. Some Effects of burnt Air ſhewn.—The Diſtempers common in Jails, and in the Holds of Ships, and the Effects of the Air in the *Grotto del Cani* at *Naples*, accounted for.

LECTURE VII.

On Electricity.

The general Laws of Electricity explained; and confirmed by a great Variety of curious and entertaining Experiments, ſhewn by taking of Sparks, giving gentle Shocks, turning little Mills with Paper-Vanes, ſtriking Holes through Cards, electrifying *plus* and *minus*, ringing of Bells, cauſing Cork-Balls with Linen Threads for Legs to move like Spiders. The Method of giving a Shock to any Part of the Body without affecting any other Part, and of preſerving Buildings from being damaged by Lightning, ſhewn.

LECTURE VIII.

On Matter, and the Laws of Motion.—Theſe Laws applied to the Motions of the celeſtial Bodies, and confirmed by Experiments on the Whirling Table, &c.

That Matter, being entirely inactive, can neither begin to move of itſelf, nor ſtop after it has been put into Motion in a free and unreſiſting Space.

The Reaſon why any Body, put into Motion, on or near the Earth, gradually loſes its Velocity, and ſoon comes to a State of Reſt.

That when Matter is put into Motion by any ſingle Impulſe, in free Space, it would for ever go on in the Direction of that Impulſe, and with an undiminiſhed Velocity.

That when two Forces act upon Matter, in different Directions, it cannot go on in the Direction of

of either of theſe Forces, but in a different Direction ariſing from both of them.

That when Matter moves in a Curve, of any Kind whatever, it muſt be acted upon by two Forces at leaſt.

That all Bodies moving in circular or elliptical Orbits, have a conſtant Tendency to fly off from theſe Orbits, and to move in rectilineal Courſes. And,

That therefore, when a Body moves in an Orbit, there muſt be a conſtant Force either drawing or impelling it towards the Centre of that Orbit.

That the Force which draws or impells a Body toward the Centre of the Orbit in which it moves, is called the *centripetal Force*; and that by which it has a conſtant Tendency to fly off from its Orbit, is called the *centrifugal Force*.

The Proportion of theſe Forces, with reſpect to each other, for retaining a Body moving in a circular Orbit, ſhewn,

That the Force by which a Body is moved forward in its Orbit, is called the *projectile* or *tangential Force*; and that the Force by which the Body is attracted or impelled towards the Centre of its Orbit, is called the *gravitating Force*; or, in general, *the Power of Gravity*.

That the Planets are moved in their Orbits by a *projectile Force* impreſſed upon them at the Beginning; and that they are retained in their Orbits by *the Power of Gravity*, which is conſtituted by the Force of the *Sun's Attraction*,

That, if the Velocities of Planets in their Orbits were *doubled*, it would require a *quadruple* Power of Gravity to retain them in their Orbits.

That when one Body moves round another in free Space, both theſe Bodies muſt move round the common Centre of Gravity between them.

That

That the Earth and Moon move round the common Centre of Gravity between them, every Month; on which Account the Earth is always nearer the Sun at the Time of Full Moon, than at the Time of New Moon.—The Quantity of this Approach towards the Sun, and Receſs from the Sun, ſhewn.

A Demonſtration of the grand Law by which all the Planets move round the Sun, and are retained in their Orbits; by which it is proved, that the Earth moves round the Sun, in common with the reſt of the Planets; and that the Power of Gravity (or Solar Attraction) diminiſhes in Proportion as the Square of the Diſtance from the Sun increaſes.

A Demonſtration of the Earth's Motion round its Axis.

The Phenomena of the Tides ſhewn by a particular Machine; and the Cauſe of their riſing equally high at the ſame Time, on oppoſite Sides of the Earth, made evident to Sight.

LECTURE IX.

On Aſtronomy, ſhewing the Phenomena ariſing from the Motions of the celeſtial Bodies in the SOLAR SYSTEM, *by Means of the* ORRERY *and* COMETARIUM.

An introductory Diſcourſe on the Uſe of Aſtronomy; and the great Benefits ariſing from the Knowledge thereof, with regard both to our religious and civil Concerns.

An Account of the Bulks of the Sun and Planets; and the Diſtances of the Planets from the Sun, as found by the Tranſit of *Venus* over the Sun on the 6th of *June*, *A. D.* 1761.

The

The annual and diurnal Motions of the Planets ſhewn by the ORRERY, and the Motions of the Comets by the COMETARIUM.

LECTURE X.

On Aſtronomy.—The ORRERY.

The Reaſon why the reſt of the Planets, ſeen from our own Planet the Earth, appear ſometimes to go backward, ſometimes forward, and ſometimes to have no Motion at all.
The different Lengths of Days and Nights, and the Viciſſitudes of the Seaſons, ſhewn.
The amazing Swiftneſs of Light demonſtrated.
The Method of finding the Longitude by the Eclipſes of *Jupiter*'s Satellites, explained.

LECTURE XI.

On Aſtronomy.—The ORRERY.

The Motions and Phaſes of the Moon, and the Length of her Days and Nights, ſhewn.
The extraordinary Benefit of Moon-Light to thoſe who live near the Pole of the Earth, ſhewn.
The Harveſt-Moon plainly accounted for.
The Appearances of the Earth, as ſeen from the Moon, deſcribed.

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LECTURE XII.

On Eclipſes, and the Darkneſs at the Time of our SAVIOUR's Crucifixion, &c.

The Earth proved to be much leſs than the Sun, and bigger than the Moon.

The Cauſes of Solar and Lunar Eclipſes ſhewn; and the Reaſon why we have ſo many New and Full Moons, and ſo few Eclipſes.

The Number, Periods, and Reſtitution of Eclipſes, ſhewn.

All the Variety of Eclipſes repreſented, as they happen in Nature.

The different Seaſons ſhewn by a Lamp, enlightening a Terreſtrial Globe in Motion.

The Eclipſes of *Jupiter*'s Satellites, and the Phenomena of *Saturn*'s Ring, ſhewn.

The Darkneſs at the Time of our SAVIOUR's Crucifixion proved to have been ſupernatural.

A remarkable Prophecy in the Book of *Daniel*, concerning the Year of our SAVIOUR's Crucifixion, explained.

The Year thereof truly aſcertained from Aſtronomical Principles, and found to agree with the above-mentioned Prophecy, *Dan.* Chap. ix. from Ver. 24. to the End.

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